Vermont Center for Geographic Information, Inc.

The Vermont LiDAR Initiative Presents:
LiDAR as a Service: Prototype Image Service

VCGI Webinar

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VERMONT

VCGI

Introduction

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- **The Vermont LiDAR Initiative** (vcgi.vermont.gov/lidar)
  - The Plan: VT State LiDAR Plan
  - The People: The EGC's LiDAR Workgroup (~ "VTeam LiDAR")
  - The Need: VT LiDAR Initiative: Critical Infrastructure brochure

- **The Enterprise GIS Consortium (EGC)** is a voluntary consortium of state government organizations focused on effective management of the State's Enterprise GIS.

- **National Digital Elevation Program (NDEP/3DEP) – 12 Federal Agencies**

- **VTeam LiDAR:** U.S. Geological Survey, National Resource Conservation Service, UVM Spatial Analysis Lab, VT Assoc. of Planning & Dev. Agencies, VCGI, VT Agency of Natural Resources, VT Agency of Transportation, Lk Champlain Basin Program, U.S. Forest Service, VT Electric Coop, VT Sustainable Jobs Fund and the VT Geological Survey.
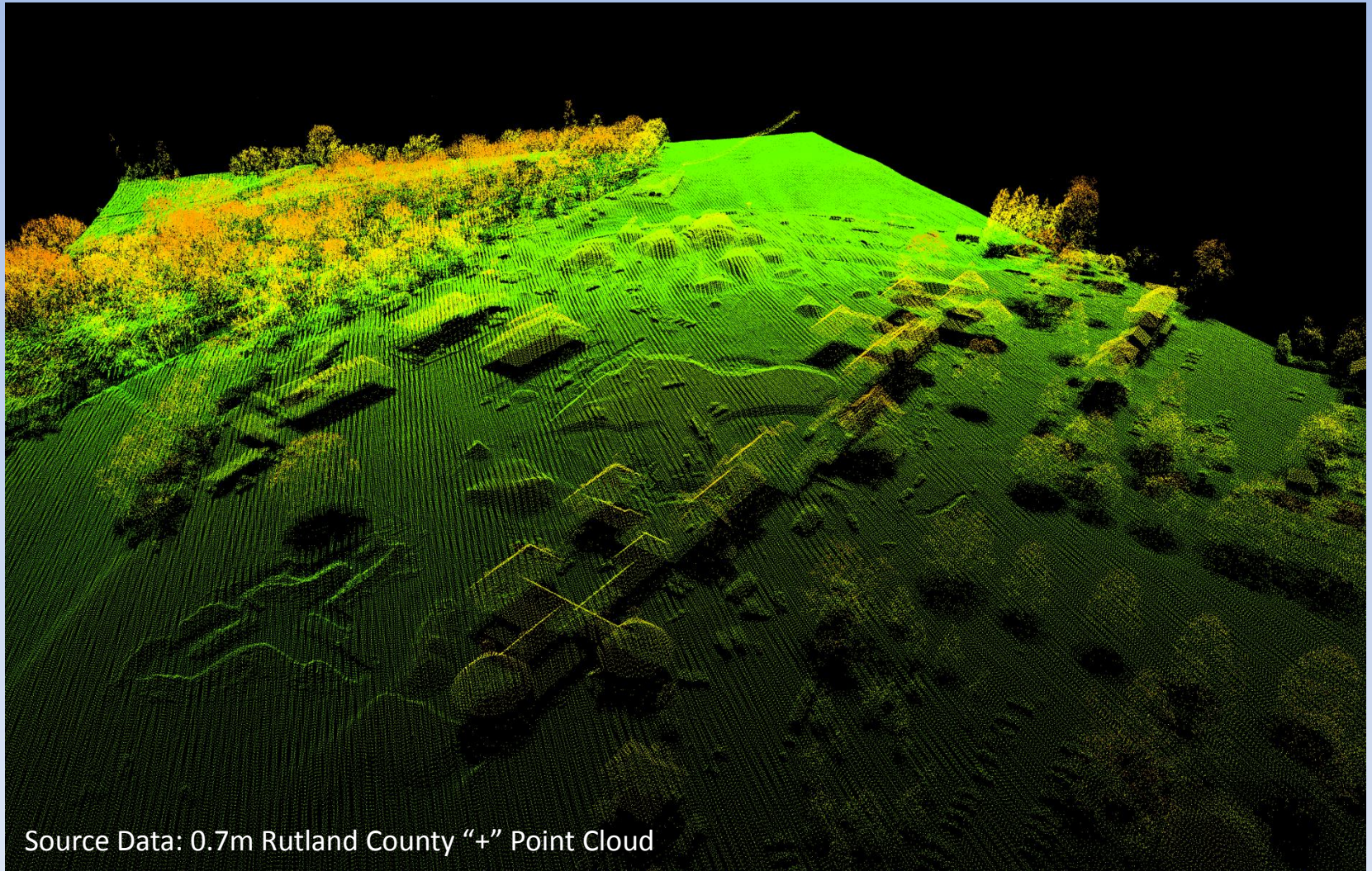
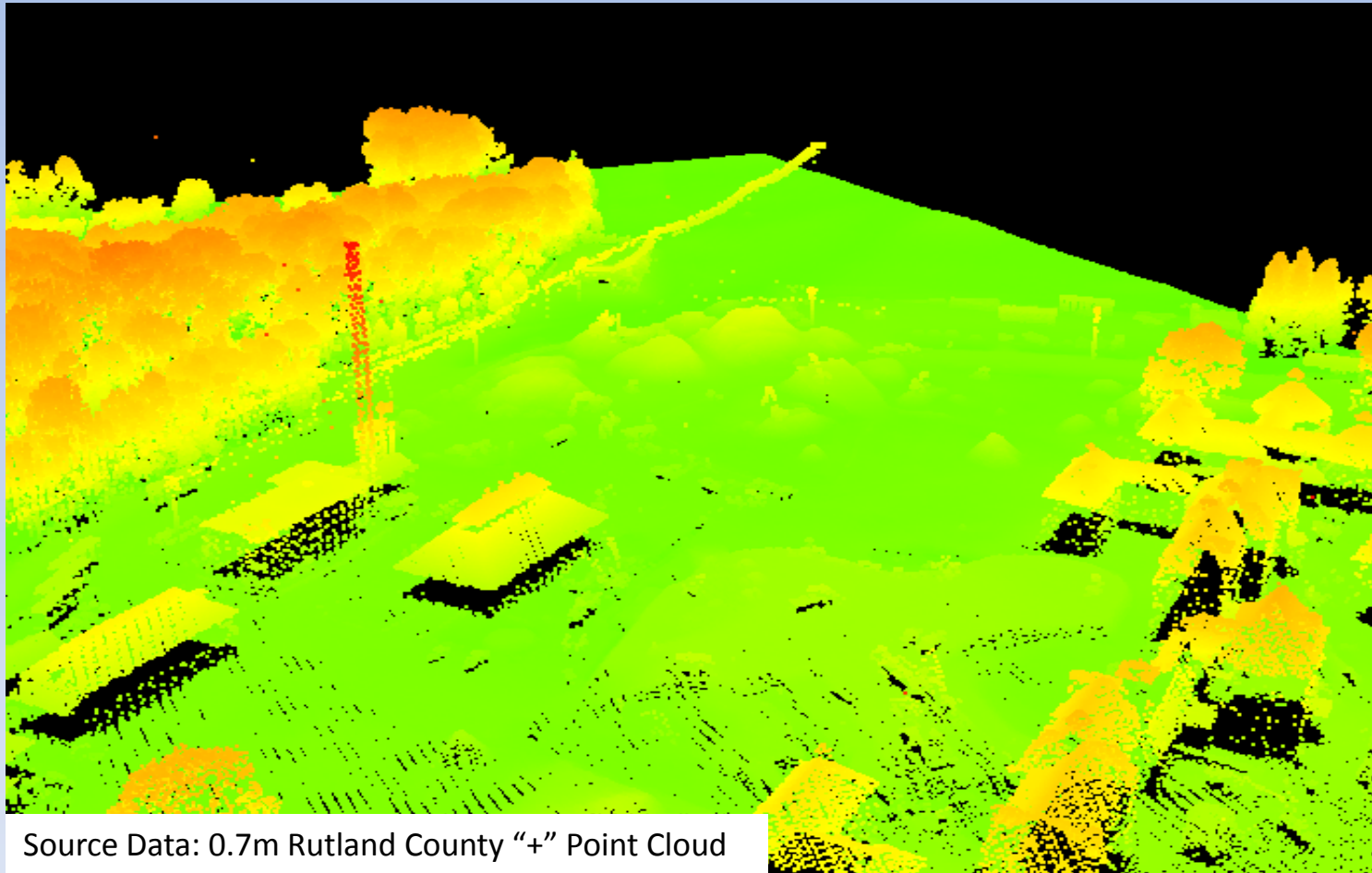# What is LiDAR?
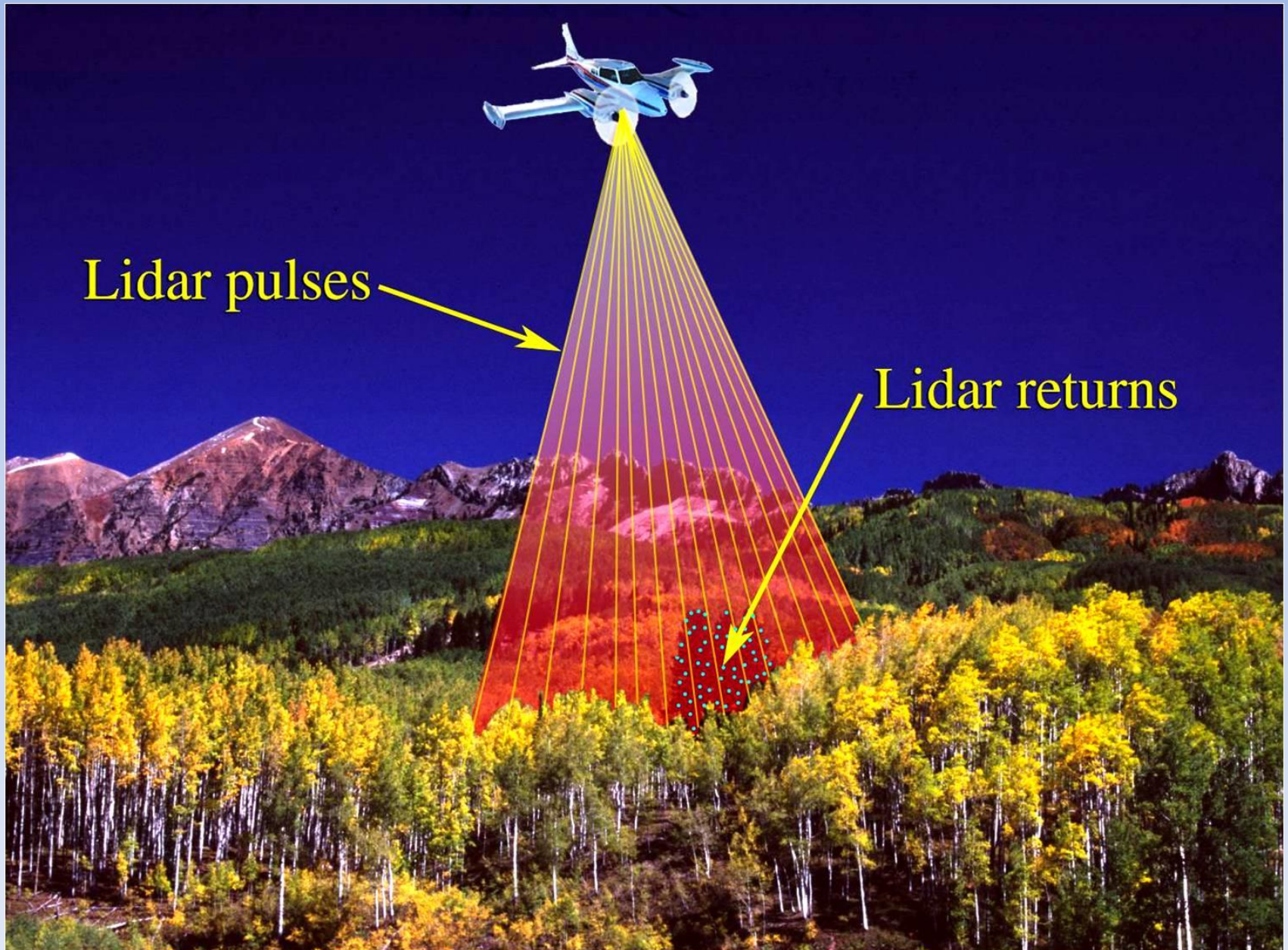
Primary LiDAR "Point Cloud" Deliverable

Source Data: 1.4m Mississquoi Point Cloud
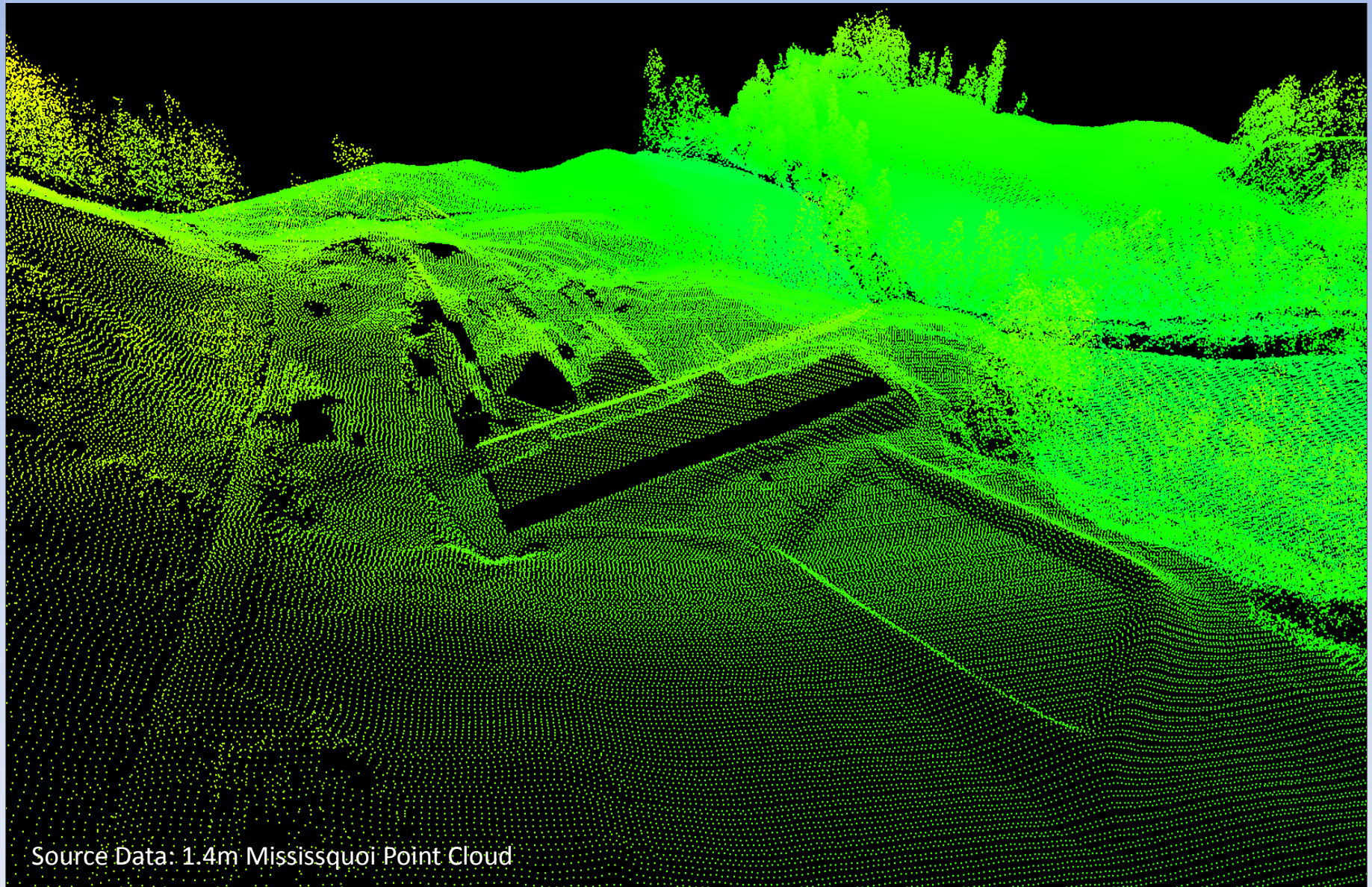
Waterbury State Complex

Source Data: 0.7m Rutland County "+" Point Cloud

Smokestack/Transmission Line

Source Data: 0.7m Rutland County "+" Point Cloud
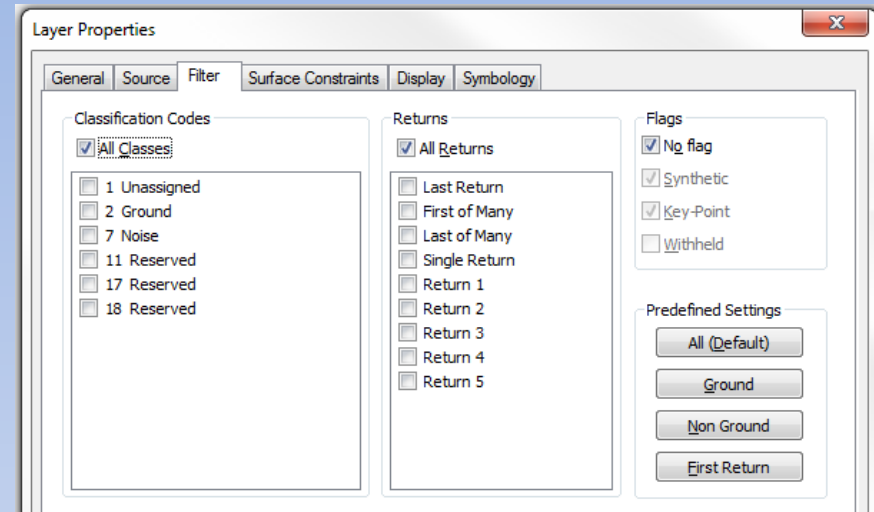
# Deriving Data from the Point Cloud

- ArcGIS LAS Dataset Properties

- LAS SPECIFICATION, Version 1.4-R13, p. 11. American Society for Photogrammetry & Remote Sensing (ASPRS), http://www.asprs.org/a/society/committees/standards/LAS_1_4_r13.pdf

Table 9: ASPRS Standard LIDAR Point Classes (Point Data Record Format 0-5)

Classification Value (bits 0:4)	Meaning
0	Created, never classified
1	Unclassified[1]
2	Ground
3	Low Vegetation
4	Medium Vegetation
5	High Vegetation
6	Building
7	Low Point (noise)
8	Model Key-point (mass point)
9	Water
10	Reserved for ASPRS Definition
11	Reserved for ASPRS Definition
12	Overlap Points[2]
13-31	Reserved for ASPRS Definition

LiDAR Infographic
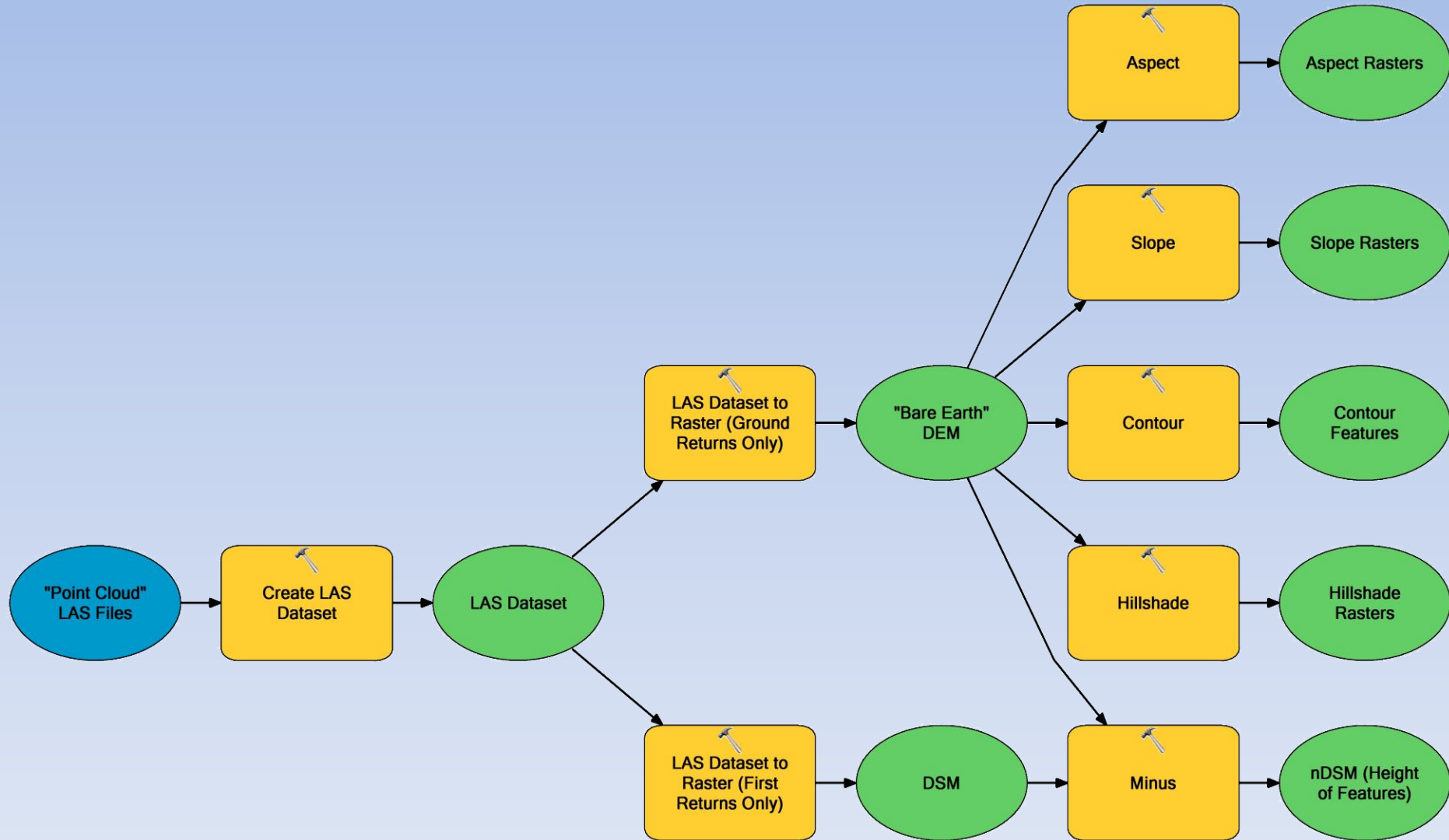
The National Digital Elevation Program: NDEP & 3DEP

- [The 3D Elevation Program—Summary of Program Direction](#)

- National Enhanced Elevation Assessment (NEEA) Results:
  - National coverage every 8 years
  - Data Quality Level 2
    - RMSz of 9.25 cm
    - 0.7m nominal point spacing
    - Supports 1 ft contours

NDEP Quality Levels (QLs)

Quality Levels	Data Source	Horizontal Resolution	Vertical Accuracy	
		Point Density	RMSEz in Open Terrain	Equivalent Contour Accuracy
QL 1	LiDAR	8 points/m²	9.25 cm	1 foot
QL 2	LiDAR	2 points/m²	9.25 cm	1 foot
QL 3	LiDAR	1 – 0.25 points/m²	≤18.5 cm	2 feet
QL 4	Imagery/ LiDAR	1 – 0.04 points/m²	46.3 – 139 cm	5 – 15 feet
QL 5	Imagery/ IFSAR	0.04 points/m²	92.7 – 185 cm	10 – 20 feet

- <u>Bathymetric LiDAR requirements</u> assessed for three Quality Levels to include Low, Standard and High. Standard Quality Level (3-5 meter post spacing; RMSEz ~ 20 cm)
- Note – USGS LiDAR base acquisition specification version 13 is = QL3 data

Existing VT Coverage

- VT Outstanding Area ~ 3,520 Sq. Mi. (~37%)

- NY Lake Champlain Basin LiDAR Project
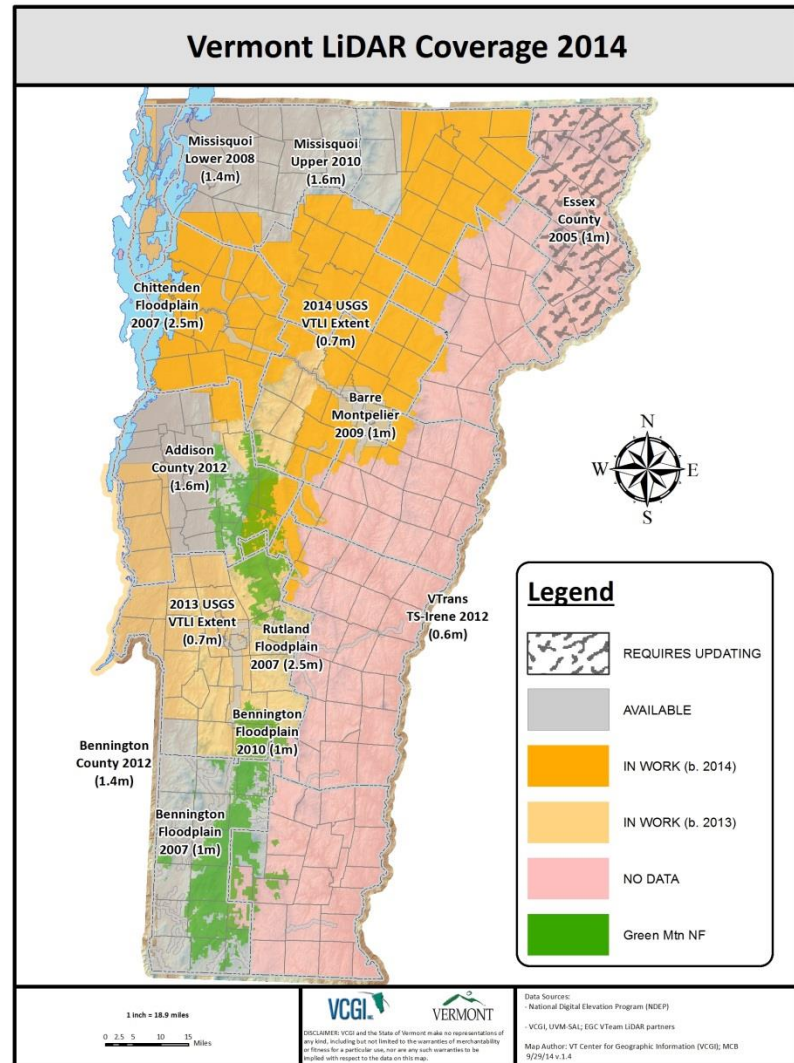
LiDAR Based Web Service Prototype

- [Addison County Prototype](#)

- State Coverage by Resolution
  - All existing coverage is "QL 3"
  - All "In Work" & future coverage is "QL 2"

- Other VT Services
  - [Enterprise GIS Services](#) (Map & Image Svcs)

Proposed Suite of LiDAR-based Web Services Created and Hosted by VCGI
In support of EGC Web Services Strategy

Name	Description	Type	Publisher
MAP_VCGI_LIDARHILLSHD_SP_CACHE_v1	LiDAR DEM Color hillshade - VT State Plane Coordinates (VTSPC)	ArcGIS map service (OGC – WCS)	VCGI
MAP_VCGI_LIDARHILLSHD_WM_CACHE_v1	LiDAR DEM Color hillshade - Web Mercator (WM)	ArcGIS map service (OGC – WCS)	VCGI
MAP_VCGI_LIDARHILLSHDPLUS_SP_CACHE_v1	LiDAR DEM Color hillshade /contours/ hydro - VTSPC	ArcGIS map service (OGC – WCS)	VCGI
MAP_VCGI_LIDARHILLSHDPLUS_WM_CACHE_v1	LiDAR DEM Color hillshade /contours/ hydro - WM	ArcGIS map service (OGC – WCS)	VCGI
MAP_VCGI_LIDARCONTOURS_SP_CACHE_v1	Contours derived from LiDAR DEM. VTSPC	ArcGIS map service (OGC – WCS)	VCGI
MAP_VCGI_LIDARCONTOURS_WM_CACHE_v1	Contours derived from LiDAR DEM - WM	ArcGIS map service (OGC – WCS)	VCGI
IMG_VCGI_LIDARDEM_SP_NOCACHE_v1	All VT LiDAR DEMs rasters	ArcGIS image svc (OGC – WMS)	VCGI
IMG_VCGI_LIDARDSM_SP_NOCACHE_v1	All VT LiDAR DSMs rasters	ArcGIS image svc (OGC – WMS)	VCGI
IMG_VCGI_LIDARNDSM_SP_NOCACHE_v1	All VT LiDAR nDSMs rasters	ArcGIS image svc (OGC – WMS)	VCGI
IMG_VCGI_LIDARASPECT_SP_NOCACHE_v1	All VT LiDAR aspect rasters	ArcGIS image svc (OGC – WMS)	VCGI
IMG_VCGI_LIDARSLOPE_SP_NOCACHE_v1	All VT LiDAR slope rasters	ArcGIS image svc (OGC – WMS)	VCGI

Data Distribution Overview

Access Options	Datasets*					Description
	DEM	*DSM*	*Contours*	*Source LAS files*	*Other Derivatives***	
External Drive Product	✓	✓	✓	✓	✓	All source and derived data. Future option w/NOAA to host LAS files online
Direct Download	✓	✓	✓		✓	Data for download
Map Services	✓***	✓	✓			1) DEM Hillshade; 2) Contours and Hillshade; 3) Contours. All cached.
Image Services	✓	✓			✓	Image services afford access to raster cell values/geo- processing. None cached.
VT Interactive Map Viewer	✓	✓	✓		✓	
* Where available; coverage is not currently statewide						
** Derivatives: Aspect, Normalized DSM (nDSM) and Slope rasters						
*** As Hillshade derived from DEM						
Note: Map and Image Services detailed in "Proposed Suite of LiDAR-based Web Services Created and Hosted by VCGI".						

Table 1. VCGI LiDAR Data Delivery Services

Accessing Available Data

- Vermont's Open GeoData Portal Download (http://vcgi.vermont.gov/opendata)
- VCGI ALL-LDR Product – Includes downloads, pending derivatives, LAS files and vendor data
- Vendor LAS files – Earth Explorer Option (now) NOAA Coastal Services Center (~2015)
- VGIS Services – Stream of Feature/Image Services (under development)
  - http://mapsdev.vcgi.org/arcgis/rest/services/VCGI_services

Technical Considerations

- Cache vs. None Cache (Current Technical difficulties with [Addison Prototype Cache](#))
- Storage/Hardware (Server side memory and disk requirements)
- Service types & configurations (Imaging, WCS, WMS)

Image service capabilities

When you publish an image service, you should consider how clients will be connecting to the image service. An image service is always published with imaging capabilities, allowing clients to connect it using an ArcGIS for Server connection or via REST. However, you can also choose to publish an image service with the Open Geospatial Consortium, Inc. (OGC) Web Map Service (WMS) or Web Coverage Service (WCS) capabilities. By adding additional capabilities you allow clients to access your image service in an expanded variety of applications and devices.

Capability	Details

Imaging	- Always enabled.
	- Rendering is typically server side (however, ArcGIS for Desktop can render on the client side).
	- Can be used for display or analysis.
	- Many advanced abilities include querying, on-the-fly processing, viewing footprints, previewing each raster, downloading, and adding. Each of these are controlled through the image service parameter settings and the imaging capability's allowed operations settings.
	- There are operations that can be allowed or limited on the image service. These include:
	  - Image—Allows the image to be displayed.
	  - Catalog—Allows the client to open the table of a mosaic dataset when it's published.
	  - Download—Allows rasters to be downloaded when publishing a mosaic dataset.
	  - Edit—Allows clients to add, delete, or update raster data published by the image service when publishing a mosaic dataset.
	  - Mensuration—Allows the client to use this image service with the mensuration tools in ArcGIS.
	  - Metadata—Allows the client to see metadata information for each raster when publishing a mosaic dataset.
	  - Pixels—Allows the API developer to access the pixel blocks of the individual rasters when publishing a mosaic dataset.

WCS	- Optionally enabled. - Allows access to the image data. - Rendering is on the client side (performed by the application). - Can be used for display or analysis.
WMS	- Optionally enabled. - Allows access to imagery as a picture. - Rendering is on the server side. - Can be used for display.

Accessing the LiDAR Imagery Services Prototype

NOTE: These prototype imagery services are for testing purposes only and will ultimately **be replaced without warning**. It is highly advised NOT to use them in a production environment.

Acquire prototype URL of interest (Use as applicable in options below):
1. Double click link from "Prototype Services" list below.
2. Select/copy URL from your web browser's navigation bar.

VCGI Prototype Services: (http://mapsdev.vcgi.org/arcgis/rest/services/VCGI_services**)**
  – VCGI_services/PROTOTYPE_VCGI_LIDARDEM_WM (ImageServer) - To access actual elevation values
  – VCGI_services/PROTOTYPE_VCGI_LIDARHILLSHD_WM_CACHE (ImageServer) – Hillshade values 0-255
  – VCGI_services/PROTOTYPE_VCGI_LIDARHILLSHD_WM (ImageServer) - Hillshade values 0-255

To access prototype in VCGI "VT Interactive Map Viewer":
1. Navigate to http://maps.vermont.gov/vcgi/vtmapviewer/, select the "Upload/Draw" tab and the "Add Map Service" (works on Imagery services too).
2. Paste link in resulting "Add Layer" dialogue box in "URL or Keywords" and select "Search".
3. Select from result(s). Change draw order from "Getting Around" tab, "Layer Drawing Order".

To Access prototype in ArcGIS online, Google Earth or ArcMap:
1. Navigate to the VCGI development site: http://mapsdev.vcgi.org/arcgis/rest/services/VCGI_services
2. Double click on the service of interest and then viewer of choice (if installed on your PC) for application to start and layer to be added automatically.

To Access prototype from within ArcMap via "Add Layer":
1. Refer to directions from the VCGI Web Services page "How to Connect to Web Services" (http://vcgi.vermont.gov/warehouse/web_services)
2. Substitute (paste) the prototype's "URL" into step 5 of the directions: "Step 5. Enter <enter URL here> into the Server URL box"

LiDAR Use Cases

- **Solar Potential Modeling** (Prototype Service)
- **Jarlath's Demo**
  - **Canopy Height Models**
  - **High-Resolution Land Cover**

Status to Date

PHASE I: (Includes 2012 Addison, 2012 Bennington and 2005 Essex Counties and the 2008/2010 Missisquoi Subbasin projects). These cover ~ 30% of the state.

- 1) COMPLETE: Make "primary derivative" LiDAR data available on the VGIS, i.e., DEM and DSM, for the largest projects;
- 2) COMPLETE: Make "secondary derivative" LiDAR data available on the VGIS, i.e., ASPECT, HILSHD, Ndsm and SLOPE for the largest projects;
- 3) COMPLETE: Integrate vendor provided 2' contours, generate 2' contours where needed to update the existing "ElevationContour_CN2T" data layer and make data available on the VGIS.

PHASE II: (Includes 2012 Addison, 2012 Bennington and 2005 Essex Counties and the 2008/2010 Missisquoi Subbasin projects). These cover ~ 30% of the state.

- 1) IN PROCESS (25%): Process prototype of Contour, DEM and DSM data into feature and image services, respectively and make available on the VGIS.
- 2) PLANNED: Process all Phase I AOI's to put Contour, DEM and DSM data into feature and image services, respectively and make available on the VGIS.

PHASE III: (Includes 2007 Bennington, Chittenden, Rutland & Washington flood plains, 2009 Barre-Montpelier, 2010 Bennington flood plains and 2012 VTrans-TSIrene projects). These cover ~6.8% of the state but not exclusive of larger projects, e.g., 2012 Bennington County vs. 2007 & 2010 Bennington floodplains.

- 1) PLANNED: Make "primary derivative" LiDAR data available on the VGIS, i.e., DEM and DSM, for the largest projects;
- 2) PLANNED: Make "secondary derivative" LiDAR data available on the VGIS, i.e., ASPECT, HILSHD, Ndsm and SLOPE for the largest projects;
- 3) PLANNED: Integrate vendor provided 2' contours, generate 2' contours where needed to update the existing "ElevationContour_CN2T" data layer and make data available on the VGIS.

PHASE IV: (Includes 2007 Bennington, Chittenden, Rutland & Washington flood plains, 2009 Barre-Montpelier, 2010 Bennington flood plains and 2012 VTrans-TSIrene projects). These cover ~6.8% of the state but not exclusive of larger projects, e.g., 2012 Bennington County vs. 2007 & 2010 Bennington floodplains.
- 1) PLANNED: Process Contour, DEM and DSM data into feature and image services, respectively and data available on the VGIS.

Open Mic

- ## VT LiDAR Initiative
  - USGS BAA proposal
  - "In-Work" Data Acquisition Update (2013 & 2014 AOI's)
  - Agency Updates
  - Other

- ## Related Efforts
  - Regional? (NY Lake Champlain "In Work" Prj)
  - National?

Resources

- ## Esri help: Resources.arcgis.com:
  - Geodata\DataTypes\LAS Dataseet\[LiDAR support in ArcGIS](#) & ~\[LiDAR Solutions in ArcGIS](#)

- ## Other
  - **Blog: Letters from the SAL** (Stream of LiDAR Consciousness) (http://letters-sal.blogspot.com/search/label/LiDAR)
  - **VT LiDAR Initiative** (vcgi.vermont.gov/lidar)
  - USGS Earth Explorer (Data – http://earthexplorer.usgs.gov/)
  - NOAA Digital Coast (Data, Tools, Training - http://csc.noaa.gov/digitalcoast/)
  - LiDAR News - http://www.lidarnews.com/
  - [LiDAR Data Quality Levels (QLs)](#) - Specifications for the varying "QLs".
  - "[Hydro Treatments of LiDAR-Derived DEMs](#)" - Options for Processing LiDAR (USGS)
  - Quick Terrain Modeler videos - (http://appliedimagery.com/tutorials).

- ## Tools
  - **ArcGIS Desktop -** Rendering: Via Windows\Image Analysis
  - LAS Tools, Quick Terrain Modeler, Global Mapper etc..

Wrap Up

Lightning Updates (Share your LiDAR related news)
- Advocacy /funding
- Applications (how are you/would you use it for?)
- Data development

Questions and Answers
- Questions for us?

Other?

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